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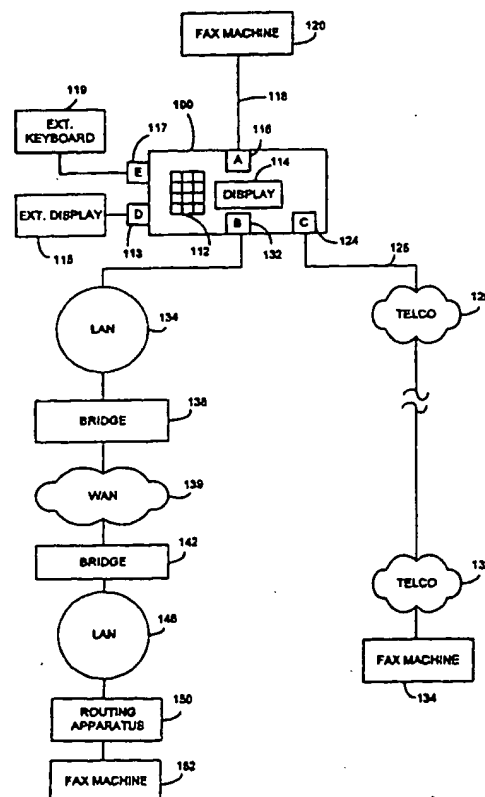


INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶: H04N 1/00, 1/32, G06F 17/00	A1	(11) International Publication Number: WO 99/21351 (43) International Publication Date: 29 April 1999 (29.04.99)
(21) International Application Number: PCT/US98/22082 (22) International Filing Date: 19 October 1998 (19.10.98) (30) Priority Data: 08/954,250 20 October 1997 (20.10.97) US (71) Applicant: ADOBE SYSTEMS INCORPORATED [US/US]; 345 Park Avenue, San Jose, CA 95110-2704 (US). (72) Inventor: KING, James, C.; 6411 Pelham Court, San Jose, CA 95123-4941 (US). (74) Agent: TROESCH, Hans, R.; Fish & Richardson P.C., Suite 100, 2200 Sand Hill Road, Menlo Park, CA 94025 (US).	(81) Designated States: BR, CN, ID, JP, KR, MX, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	

(54) Title: FACSIMILE ROUTING**(57) Abstract**

An apparatus (100) links a fax machine (120) to a telephone network (126) and a computer network (139). The apparatus (100) allows the user to selectively route facsimile transmission over a computer network (134, 139, and 146) to reduce long distance transmission costs. A key pad (112) and a display (114) are provided for entering destination addresses and providing visual feedbacks to the user. When transmission over the telephone line (125) is requested, the apparatus (100) directly links the fax machines (120 and 134) over a telephone system (126 and 132). However, if the fax transmission is to be transmitted over a WAN (139), including the Internet, the apparatus (100) intercepts the facsimile transmission, converts the information into a suitable electronic format for attachment to an electronic mail, and routes the transmission to the destination (152) over a WAN (139) or Internet to reduce long distance fax transmission charges from the telephone company. The apparatus (100) can also accept electronic mail and converts them into an acceptable format for reception by conventional fax machines.



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FACSIMILE ROUTING

BACKGROUND

5 The present invention relates to apparatus and methods for routing information over communications networks, and more particularly, to apparatus and methods for routing facsimile information over communication networks.

The transmission of graphical information such as facsimile (fax) information is a complex interchange where two fax machines exchange information over conventional telephone circuits. When facsimiles are sent to local
10 destinations, they are local calls and are relatively inexpensive. However, according to a 1993 Gallup/Pitney Bowes study on fax usage, about 41% of U.S. business telephone expenditures are fax related and 74% of those fax calls use long distance connections. Hence, long distance charges can be a significant component of the total operating cost of a fax machine.

15 In comparison, the cost of transmitting data over computer networks is relatively independent of the local-long distance characterization. Thus, when long distance transmissions are involved, it is generally more cost effective to communicate data over computer networks such as local area networks (LANs) or wide area networks (WANs) rather than telephone lines. However, conventional
20 fax machines cannot connect to and communicate directly with computer networks. Moreover, conventional fax machines cannot convert the fax information into electronic mail, or attachments to electronic mail. Furthermore, keypads of conventional fax machines do not provide for entering electronic mail addresses.

SUMMARY

25 A routing apparatus is provided which selectively links a graphics transmission equipment such as a fax machine to a first network using a telephone line, and/or to a second network such as a computer network. The apparatus has a plurality of ports to permit communication over telephone and computer networks.
30 The apparatus also has a display which provides a visual feedback to users. A keypad is provided to accept destination e-mail addresses corresponding to

conventional fax numbers, and which may be suitably encoded strings representative of electronic mail (e-mail) addresses.

The apparatus detects whether the user wishes to send a fax over the first network or the second network by decoding a number entered as a destination. If
5 the user wishes to transmit the fax using the telephone network in a conventional fashion, the apparatus simply forwards the fax transmission over the telephone network. Alternatively, if the fax number conforms to a predetermined protocol which indicates that the transmission is to be routed over a computer network, an electronic mail address is generated based on the entered destination. The fax
10 transmission is captured, converted into a suitable format, and forwarded to the destination as electronic mail, or as an attachment to electronic mail.

The apparatus can be deployed singly or in pairs to link fax machines over the network. If operating alone, the apparatus can route transmissions from an attached fax machine to a computer connected to the computer network. The
15 electronic mail and/or electronic mail attachments can be read by the computer at the destination. Also, if operating alone, the apparatus can receive e-mail and convert it to a fax format, and print the document on the associated fax machine.

If operating in pairs, a second routing apparatus connected to the computer network is deployed for driving a second fax machine. In this configuration, the
20 electronic mail is routed over the computer network. The electronic mail (e-mail) is received and processed by the second routing apparatus. The second apparatus converts the e-mail and/or e-mail attachments back into a fax compatible format and directs a fax transmission to the attached second fax machine. The pair of fax machines can thus communicate using the computer network to reduce long
25 distance charges.

Among the advantages of the invention are one or more of the following. The apparatus establishes a link between an international network of fax machines and an international network of computers exchanging electronic mail. Fax transmissions are flexibly routed over a plurality of communication networks to
30 minimize long-distance charges. Further, the apparatus allows users to send and receive electronic mail using conventional fax machines. Destination addresses are

conveniently and quickly generated by converting suitably encoded keypad entries into e-mail addresses.

Moreover, information sent over a conventional fax machine is converted and stored in a digital format suitable for transmission to other fax machines or computers with a resulting reduction in communication costs. The apparatus is inexpensive, easy to operate, and works with minimal space, power and cooling requirements.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A illustrates a routing apparatus as deployed in a first configuration.

Figure 1B illustrates the routing apparatus as deployed in a second configuration.

Figure 1C illustrates the routing apparatus as deployed in a third configuration.

Figure 1D illustrates the routing apparatus as deployed in a fourth configuration.

Figure 1E illustrates the routing apparatus as deployed in a fifth configuration.

Figure 2 is a schematic illustration of the routing apparatus of Figures 1A, 1B, 1C, 1D and 1E.

Figure 3 is a flow chart illustrating a process of sending information using the apparatus of Figure 2.

Figure 4 is a flow chart illustrating in more detail the process for converting a telephone number into an electronic mail address in accordance with Figure 3.

Figure 5 is a flow chart illustrating an embodiment of a process for preparing a file for transmission in accordance with Figure 3.

Figure 6 is a flow chart illustrating a process for receiving fax information by electronic mail in accordance with Figure 1D or 1E.

DESCRIPTION

Referring now to Figure 1A, an operating environment is shown for a facsimile routing apparatus 100. In the operating environment of Figure 1A, the

facsimile routing apparatus 100 transmits data from a facsimile machine 120 directly to a second fax machine 134 using a conventional telephone network. Alternatively, the apparatus 100 can transmit data to a third fax machine 152 using a computer network. The apparatus 100 preferably has a keypad 112 for receiving
5 destination information, including telephone numbers and/or strings representative of electronic mail addresses. To provide for easier data entry, an external keyboard 119 may be connected to the apparatus 100 by an E port 117. The external keyboard 119 may be a full QWERTY keyboard so that users can enter data more accurately and quickly.

10 The apparatus 100 also has a display 114 for providing a visual feedback to users on the destination information entered using the key pad 112 or keyboard 119. The display 114 may be a small liquid crystal display (LCD) sufficient to display a telephone number. Also, to provide for more graphics capability, an external display 115 may be connected to the apparatus 100 by a D port 113. The
15 external display 115 may be used to display not only the information entered by the keypad 112, but also the content of the transmission such as a fax image being routed through the apparatus 100.

The apparatus 100 further has a plurality of ports: an A port 116, a B port 132 and a C port 124. The A port 116 is connected to a facsimile machine 120 by
20 a first telephone wire 118. Similarly, the C port 124 is connected to the telephone network 126 by a second telephone wire 125. The telephone network 126 in turn is connected to a second telephone network 132. A fax machine 134 may be connected to the telephone network 132 at a remote location. Connectors for the A and C ports 116 and 124 would typically be RJ-11 type telephone connectors.

25 The B port 132 is connected to a local area network (LAN) 134. The LAN 134 in turn is connected to one or more workstations (not shown) and/or other computers such as personal computers and servers. The LAN 134 is also connected to a wide area network (WAN) 139, for example by a bridge 138. A second bridge 142 in turn connects the WAN 139 to a remote LAN 146.
30 Connected to the remote LAN 146 is a second facsimile routing apparatus 150, which is identical to the facsimile routing apparatus 100. The second apparatus 150 receives information captured in a first format such as an e-mail format from

the first apparatus 100, converts the first format to a fax format, and provides the fax format data to a third fax machine 152. In this way, two fax machines 120 and 152, each with associated facsimile routing apparatus 100 and 150, are able to send faxes to each other using a computer network.

5 The operating embodiment shown in Figure 1A thus can capture a fax transmission encoded in a first format from the first fax machine 120 and transmits the information over the conventional telephone network to the second fax machine 134 in a conventional manner. Alternatively, fax formatted data from the first fax machine 120 may be converted into a second format such as an e-mail format and
10 transmitted over a computer network to the second apparatus 150. The second apparatus 150 in turn reconverts the e-mail formatted transmission back into a fax format and provides the fax format data to the third fax machine 152. As the data from the first fax machine 120 is transmitted over the computer network, each of fax machines 120 and 152 incurs only local telephone call expenses, if any, and
15 avoids long-distance telephone charges. Usually, the connections to the LANs 134 and 146 involve no phone calls.

 Referring now to Figure 1B, a second operating environment for the facsimile routing apparatus 100 is shown. In this environment, the WAN 139 is replaced by the Internet 140, which is a number of computer systems linked
20 together by a backbone telecommunications network. Multiple networks can also be linked together and connected to the Internet 140 by hubs that enable computers on these networks to talk to one another and to other computers elsewhere on the Internet 140. The Internet 140 is thus able to have a global presence.

 In the operating environment of Figure 1B, the apparatus 100 receives fax
25 format data from the fax machine 120, converts the fax format data into the e-mail format and sends data to the second apparatus 150 over the Internet. The data is eventually received by the second apparatus 150 which is connected to the LAN 146. The second apparatus 150 converts the data from the e-mail format back to the fax format and provides this data to the second fax machine 152, as discussed
30 earlier. Due to the ubiquity of the Internet, data transmission occurs at a relatively low cost over a widely accessible network.

Referring now to Figure 1C, a third operating environment for the facsimile routing apparatus 100 is shown. Since the apparatus 100 as shown in Figure 1C converts facsimile pages into electronic mail format in order to send the pages using a computer network, the destination may be a computer instead of another fax machine. The environment of Figure 1C is similar to that of Figure 1B, except that the transmission from the fax machine 120 may be sent to a computer with fax-modem capability. In Figure 1C, data transmitted over the Internet 140 is routed to the destination through an Internet service provider (ISP) 180.

The ISP 180 is typically connected to the Internet 140 by a T-1 or T-3 connection. The ISP 180 in turn is linked to a computer 184 by a communication line, typically a telephone line, an integrated services data network (ISDN) line or a cable line, and a suitable modem 182. The computer 184 is connected to a display 186 and a printer 188 for viewing or making a hard copy of the e-mail transmission. In this manner, data transmitted from the facsimile machine 120 can be routed to reach the computer 184 over the Internet 140, or vice versa.

Figure 1D illustrates the operating environment of Figure 1A, with the addition of electronic mail servers 190 and 192 which are connected to LANs 134 and 146, respectively. The servers 190 and 192 provide central depositories for temporary buffering of incoming and outgoing electronic mail.

Figure 1E illustrates the connection of the apparatus 100 to the Internet by way of an alternate means different from that of Figure 1B. In Figure 1E, the modem port C is used to connect to an ISP using the conventional telephone system. This connection would, in most case, be a local telephone connection rather than a long distance call.

As used in the configurations of Figures 1A-1E, the apparatus 100 and 150 tap into the ubiquity of the wide area network 139 or the Internet 140 to generate cost savings to users by reducing expenses associated with long-distance telephone fax transmissions. Yet, the routing apparatus 100 retains the flexibility of sending facsimiles by conventional telephone network, if necessary.

A block diagram of components of one embodiment of the apparatus 100 is shown in Figure 2. A microcontroller 160 provides processing capability. A conventional microprocessor or central processing unit (CPU) may be used instead.

The microcontroller 160 is connected to a read only memory (ROM) 162 and a random access memory (RAM) 164 to access instructions and data. The microcontroller 160 is also connected to the key pad 112 and the display 114 to receive user data entry as well as provide visual feedback.

5 The microcontroller 160 is optionally connected to a video converter 166 for driving the external display 115 over the D port 113. The microcontroller 160 is further optionally connected to a keyboard interface unit 168 for receiving user data entry from the external keyboard 119 over the E port 117.

 The microcontroller 160 is connected to a first fax-modem 170. The first
10 fax-modem 170 is connected to a fax machine 120 via the telephone wiring 118 by the A port 116. A second fax-modem 172 is connected to the microcontroller 160. The second fax-modem 172 is also connected to the telephone line 125 by the C port 124. To access the computer network, the microcontroller 160 is connected to a network interface card (NIC) 174. The output of the NIC 174 is provided to the
15 B port 132, which in turn is connected to the LAN 134 (Figures 1A, 1B or 1C). As the LAN 134 is eventually connected to the WAN 139 (Figure 1A) or the Internet 140 (Figures 1B or 1C), the microcontroller 160 can route incoming fax data to a remote fax machine or a computer over a long distance network.

 Referring now to Figure 3, the process for sending a fax using the apparatus
20 100 is illustrated. In this process, at the fax machine, the user enters either a conventional fax destination number to send a fax using the telephone network, or a pseudo-telephone number with a unique prefix to signal the apparatus 100 that it is to transmit the fax using the computer network in place of the telephone network. The pseudo-telephone number allows the standard set of telephone
25 numbers that traditional fax machines are prepared to deal with to be used to designate an e-mail address.

 During a conventional fax transmission process, the user enters a fax destination by entering a phone number in the fax machine 120 of Figure 1A-1E. In response, the fax machine 120 accesses the telephone network by first accessing
30 the apparatus 100 of Figures 1A-1E through the connection 118 and port A 116. The apparatus 100 in turn completes an actual connection to the telephone network 126 using port C 124 and the connection 125. The phone number entered by the

user is used to dial the number for the destination fax machine over the connection 125. Upon making a connection with the destination fax machine, the apparatus transmits data to the destination fax machine.

If the fax transmission is to be performed over the wide area network 139
5 or Internet 140, the user enters information encoded as a pseudo-telephone number. Any sequence of digits that would not interfere with the placement of a conventional telephone call may be used. For example, any number that begins with "99" indicates that the fax is to be sent over a computer network as no regular telephone call would start with the digits "99".

10 More particularly, referring to Figure 3, the send process 200 first checks whether the user has entered a preference (step 202). If the user wishes to send the transmission by the telephone line (plain old telephone system, or "POTS"), as is conventional, the send process 200 uses the destination fax number dialed by the fax machine and passes the facsimile transmission directly from the sending fax
15 machine to the destination fax machine using the telephone line (step 204).

Step 204 is performed in five phases: phase a - call set up or call establishment; phase b - pre-message procedure; phase c - message transmissions; phase d - post message procedure; and phase e - call release. The process 204 performs phases a and e once per fax transmission forwarding operation and phases
20 b, c and d as often as necessary to complete the forwarded transmission. After the forwarding operation has been completed, the process 200 exits in step 250.

If the fax transmission is to be routed over the wide area network 139 or the Internet 140, the send process 200 generates an e-mail address in step 222 as a function of the phone number with a predetermined protocol, such as the prefix
25 "99" previously entered by the user at the fax machine. Step 222 is discussed in more detail in Figure 4.

Next, the send process 200 prepares the file for transmission (step 224), as discussed in more detail in Figure 5. From step 224, the routine of Figure 3 sends the fax via the local area network 134, the wide area network 139 or the Internet
30 140. The send process 200 then checks whether the transmission was successful (step 228). In the event of a failure, the send process 200 indicates an error to the

user (step 230) before exiting (step 250). Alternatively, in the event of a successful transmission, the routine of Figure 3 exits (step 250).

Referring now to Figure 4, the process 222 of Figure 3 is shown in more detail. The software in the apparatus maintains a directory associating "pseudo"
5 telephone numbers with e-mail addresses. The process 222 initially examines the destination information and checks whether an address which is not listed in the directory is to be generated (step 262). If so, the user is prompted to enter the address using the key-pad 112 (step 272). Otherwise, the process 222 looks up the e-mail address based on the entered telephone number supplied via the fax machine
10 (step 264).

From step 264, the process 222 checks whether the search of the look-up step 264 was successful (step 266). If not, an error is indicated (step 268) before the process proceeds to step 272. If a valid address was entered (step 272) or the e-mail address look-up was successful (step 266), the process 222 sets the
15 destination information using the newly-generated e-mail address (step 270) before exiting (step 274).

Figure 5 illustrates one embodiment of the process 224 (Figure 3) for preparing a file for transmission. A process 224 checks whether the fax image is to be attached as an image file to the electronic mail message (step 276). If so, the
20 process 224 attaches the fax image to the electronic mail message body (step 277). The fax image may be formatted using a standard format for e-mail attachments, such as TIFF, JPEG or MPEG, PDF, among others. From step 277, the routine of Figure 5 exits (step 281).

From step 276, if additional processing is to be performed on the fax image
25 to enhance the usability of the fax, the fax image is processed by a suitable document recognition engine, such as an Adobe Acrobat Capture® engine, available from Adobe Systems Incorporated of San Jose, California. Other suitable optical character recognition engines may be used (step 278).

After the fax image has been processed in step 278, the process 224A
30 attaches the result to the e-mail message (step 279) before exiting (step 281).

Referring to Figure 6, a process 330 in the apparatus for receiving information by electronic mail is shown. The process 330 initially polls a mail

server 190 or 192 connected to the apparatus by LAN 134 in Figures 1A-1E or by WAN 139 or the Internet 140 in Figures 1A-1E for messages (step 332). The process 330 then checks whether messages are available from the mail server (step 333). If not, the process 330 puts itself to sleep (step 336) and periodically wakes
5 up to continue polling the server for messages.

When a message is received (step 334), the process 330 converts the electronic mail file to the fax image format (step 338). Next, the converted image is sent to the attached facsimile machine (step 340) via the connection 118 in Figures 1A-1C before exiting (step 342). In this manner, the fax transmission is
10 routed over the WAN 139 or Internet 140 and converted into a fax format before being transmitted to this destination fax machine.

Thus, two facsimile machines, both having associated apparatus 100 and 150, are directly linked by the telephone network. However, if the fax transmission is to be transmitted over a WAN, including the Internet, the first apparatus 100
15 intercepts the facsimile transmission, converts the information into a suitable electronic medium for attachment to an electronic mail, and routes the transmission to the destination over the WAN or Internet. The second or receiving apparatus 150 then converts the e-mail back into a fax form suitable for output on the second receiving fax machine.

20 Since each apparatus and fax machine pair is capable of sending either regular faxes over regular telephone lines or faxes converted to e-mail over the Internet or other LANs and WANs and can convert between the two formats, the following types of transmissions are supported:

- Computer user generates e-mail which are sent to and output on a fax
25 machine;
- Fax transmissions which are sent to and read as e-mail by computer users; and
- Fax transmissions which are cost-effectively sent to other fax machines over the Internet rather than long distance telephone lines.

30 Variations to the fax routing apparatus are within the scope of the claims. For example, although the apparatus has two telephone line connections to link two fax machines over the telephone network, the apparatus may use one telephone

connection to receive and buffer the transmission into its memory and, at the end of the transmission, in turn call the destination fax machine and transmit the fax information stored in memory to the destination fax machine. Further, in place of a directory look-up to generate e-mail addresses, other suitable methods may be used, including detecting and capturing the e-mail address located on the document to be transmitted, among others.

Additionally, to aid users in categorizing and handling documents routed by the apparatus, the invention contemplates that key words such as "from", "to", "title", "date", among others, can be extracted from the fax transmission and appended to e-mail documents, or vice versa. Moreover, to simplify computer access to the document, the invention contemplates that the document being faxed is converted into a suitable graphics file standard such as a Tagged Image File Format (TIFF), JPEG, MPEG, or PDF file. Alternatively, the document can be saved as a computer readable text file using an appropriate optical character recognition (OCR) engine. Further, the computer readable file may be compressed to reduce storage space and transmission time.

Other embodiments are within the scope of the following claims.

WHAT IS CLAIMED IS:

1. An information routing apparatus, comprising:
a processor;
5 a first port coupled to the processor for communicating information encoded in a first format;
a second port coupled to the processor for communicating information encoded in a second format; and
a destination detector coupled to the processor for determining whether a
10 message received over the first port is to be rerouted to the second port.
2. The apparatus of claim 1, further comprising a third port coupled to the processor for communicating a message encoded in the first format.
- 15 3. The apparatus of claim 1, wherein the first port is connected to a fax machine.
4. The apparatus of claim 1, wherein the second port is connected to a computer network, further comprising a format converter coupled to the destination
20 detector for formatting the message to the second format.
5. The apparatus of claim 1, wherein the first format is a facsimile transmission format.
- 25 6. The apparatus of claim 1, wherein the second format is an e-mail transmission format.
7. The apparatus of claim 1, wherein the second port is connected to the Internet.
- 30 8. The apparatus of claim 1, wherein the message has a destination address and a destination flag, further comprising:

a database storing one or more first destination addresses and for each of the first destination addresses, one or more corresponding second destination addresses, wherein if the destination flag indicates the message is to be rerouted, the destination detector presents the first destination address to the database,
5 receives a corresponding second destination address and routes the message to the second destination address.

9. The apparatus of claim 1, further comprising:

a third port coupled to the processor for communicating a message encoded
10 in the first format, wherein the destination detector obtains a destination address from the first port and determines whether the message is to be sent over the third port or rerouted to the second port with a corresponding second destination address.

10. A system for routing a message over a computer network, comprising:

15 a sending apparatus coupled to the computer network, including:

a processor;

a first port coupled to the processor for communicating information encoded in a first format;

20 a second port coupled to the processor and to the computer network for communicating information encoded in a second format;

a destination detector coupled to the processor for determining whether a message to be sent over the first port is to be rerouted to the second port; and

25 a format converter coupled to the destination detector for formatting the message being rerouted to the second format; and

a receiving apparatus coupled to the computer network, including:

a second processor;

a third port coupled to the second processor for communicating information encoded in the first format;

30 a fourth port coupled to the second processor and to the computer network for communicating information encoded in the second format; and

a format converter coupled to the second processor for formatting the rerouted message from the second format to the first format.

11. The system of claim 10, wherein each of the sending and receiving
5 apparatus has a port coupled to the respective processor for communication a message encoded in the first format.
12. The system of claim 11, wherein the first and third ports are connected to fax machines using plain old telephone service (POTS) wiring and protocols.
- 10 13. The system of claim 10, wherein the first format is a facsimile transmission format.
14. The system of claim 10, wherein the computer network is the Internet.
- 15 15. The system of claim 10, wherein the message has a destination address and wherein the destination detector further comprises a database storing one or more first destination addresses and for each of the first destination addresses, a corresponding second destination address,
- 20 wherein the destination detector presents the first destination address to the database, receives the corresponding second destination address and applies the second destination address in routing the message.
16. A method for routing a message transmitted from a first port, comprising:
25 receiving a destination address; and
examining the destination address to see if the message is to be transmitted using another port and if so, rerouting the message to a second port having a second data format, including:
- 30 generating a second address for the second port;
intercepting the message transmitted over the first port in a first data format;
converting the message to the second data format; and

sending the message to the second port at the second address.

17. The method of claim 16, wherein the intercepting step intercepts a facsimile
5 transmission.
18. The method of claim 16, wherein the determining step further comprises the step of detecting a predetermined code indicating that the message is to be rerouted.
- 10 19. The method of claim 16, wherein the address generating step further comprises:
looking up a database having one or more first destination addresses and second destination addresses corresponding to the first destination addresses; and
applying the resulting second destination address as the address of the
15 second port.
20. The method of claim 16, further comprising the step of appending one or more key words to the message.
- 20 21. The method of claim 16, further comprising the steps of performing optical character recognition on the message and storing the message as text.
22. The method of claim 16, further comprising the steps of:
receiving the message in the second format;
25 converting the message into the first format; and
sending the message to the destination address.
23. The method of claim 16, further comprising the step of communicating messages using an Internet service provider (ISP).

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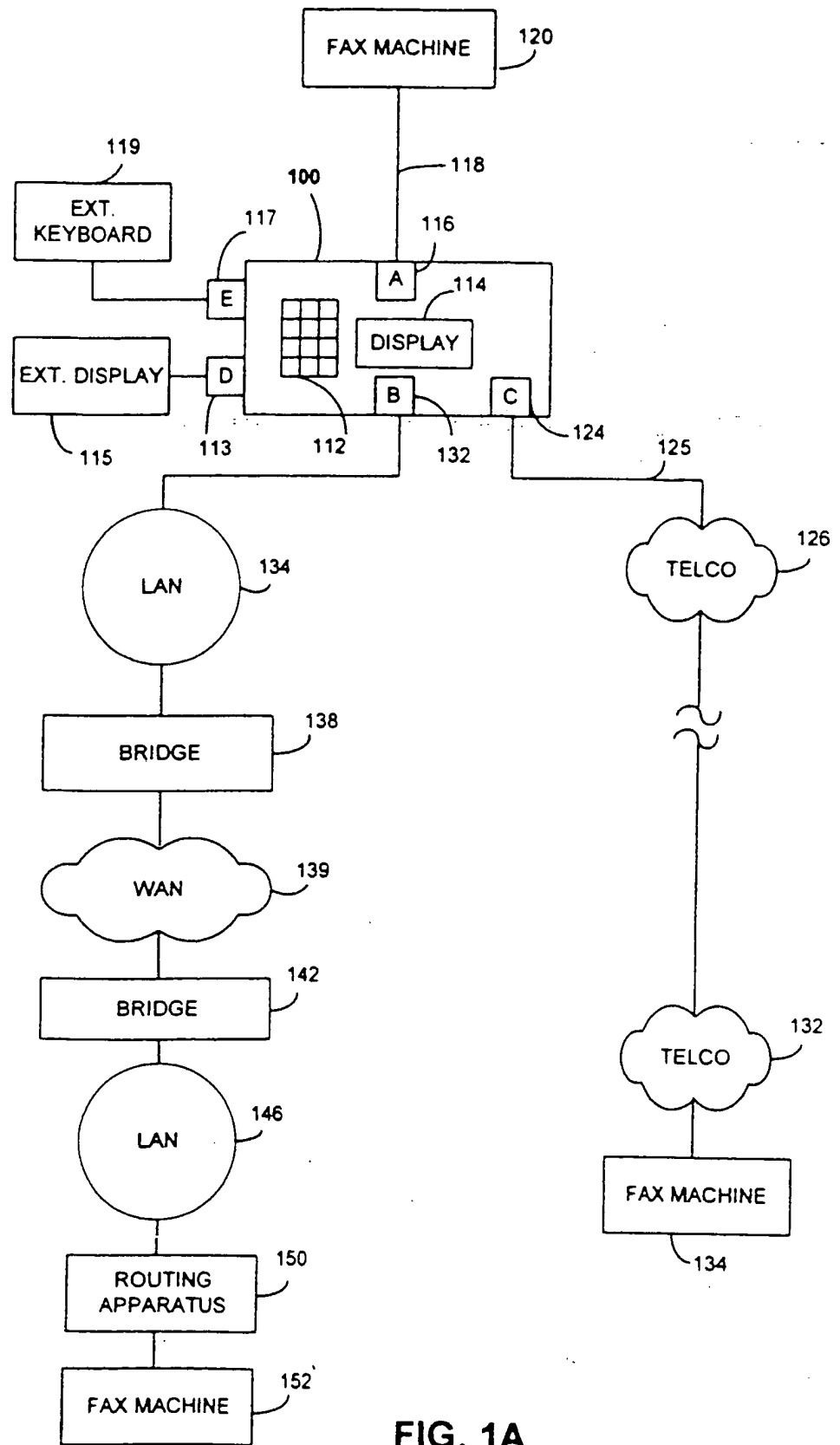


FIG. 1A

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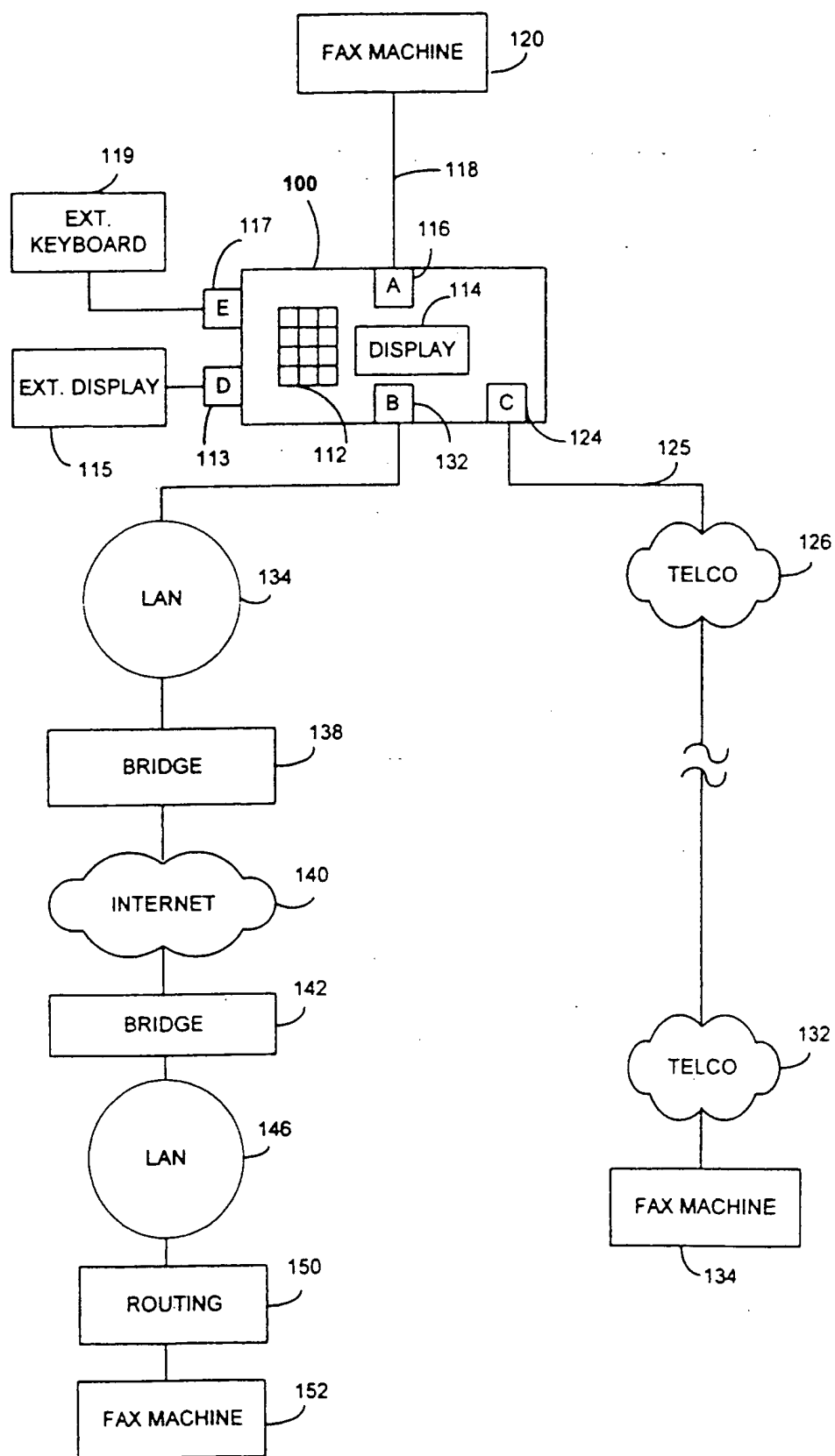


FIG. 1B

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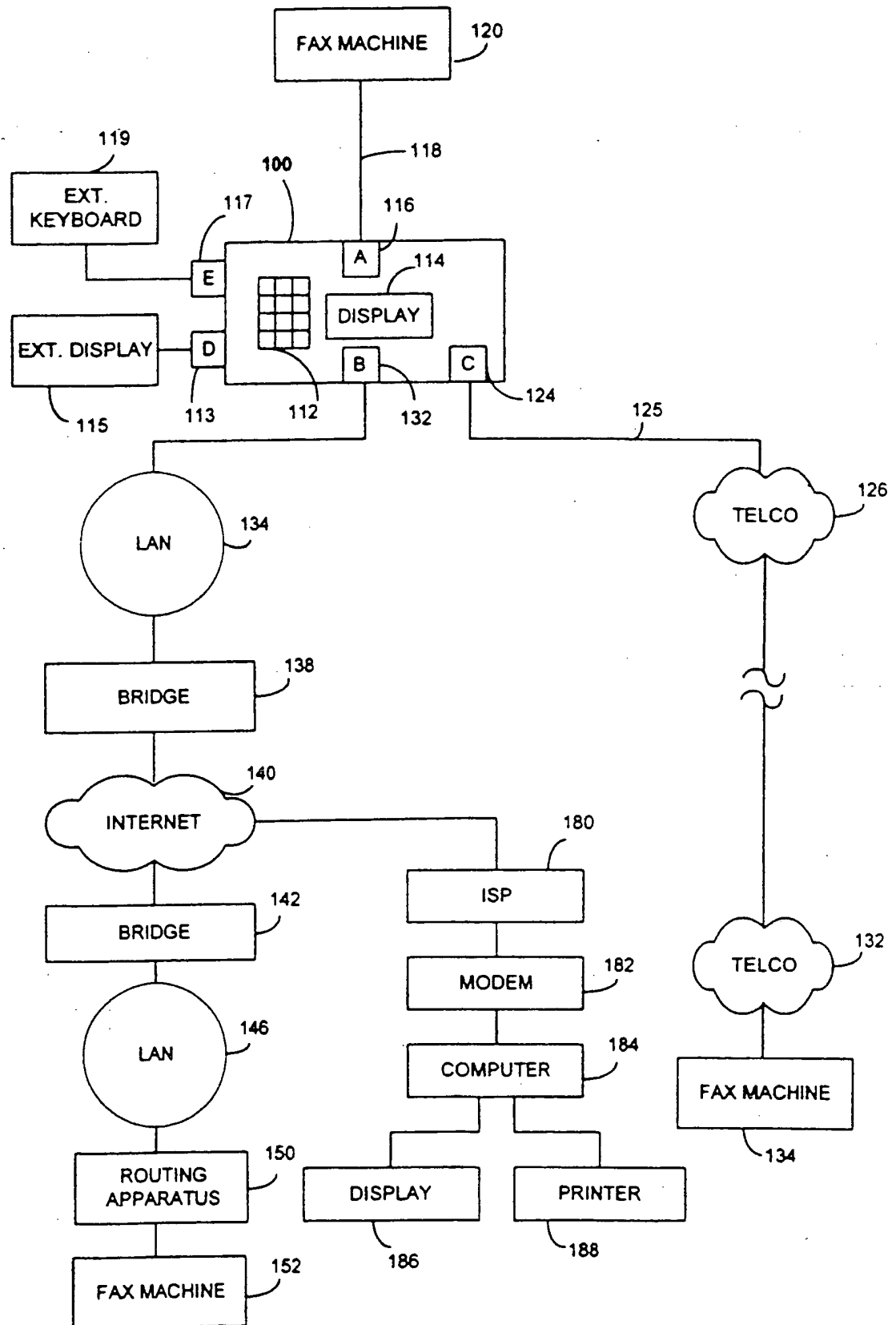


FIG. 1C

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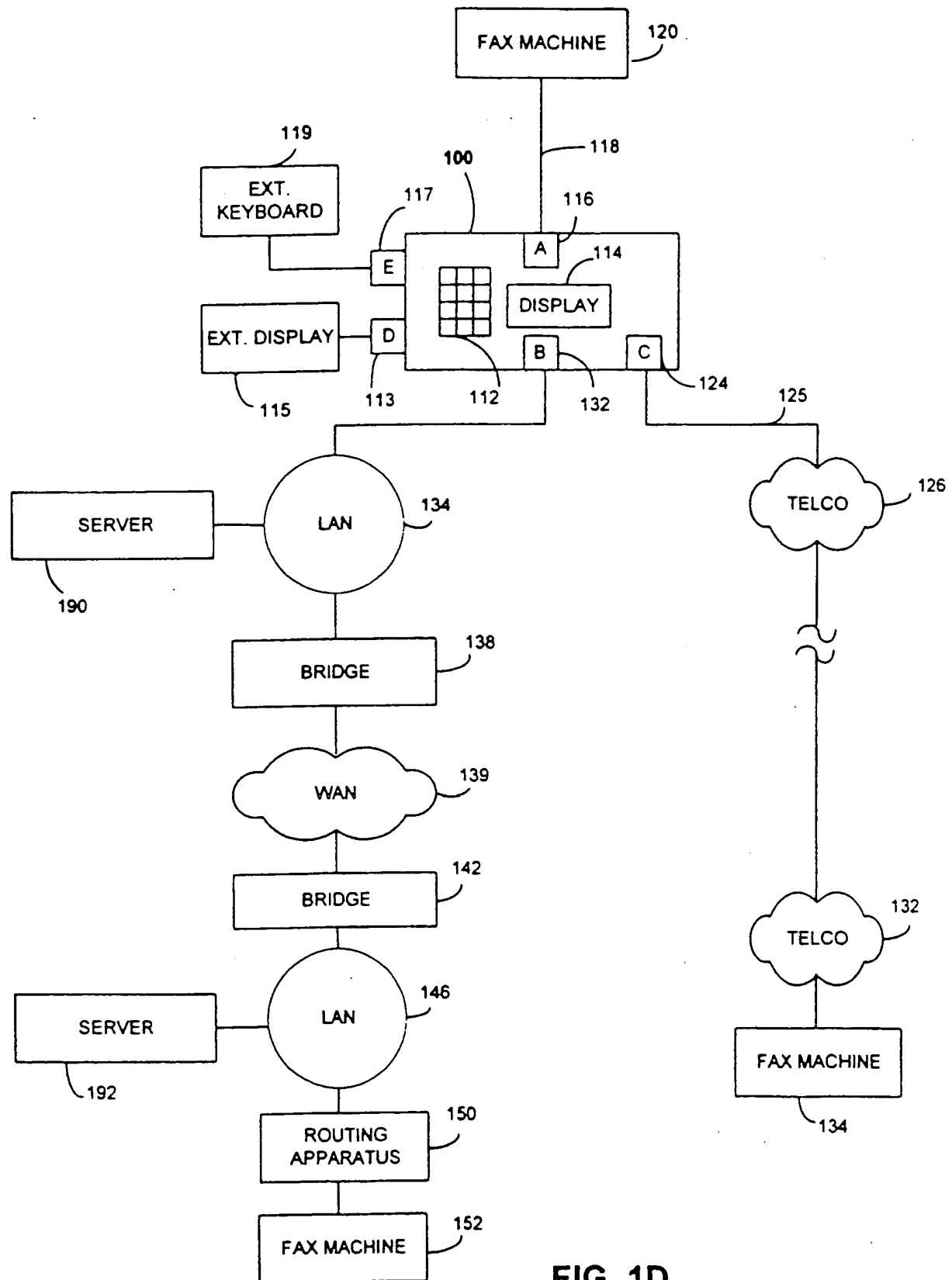


FIG. 1D

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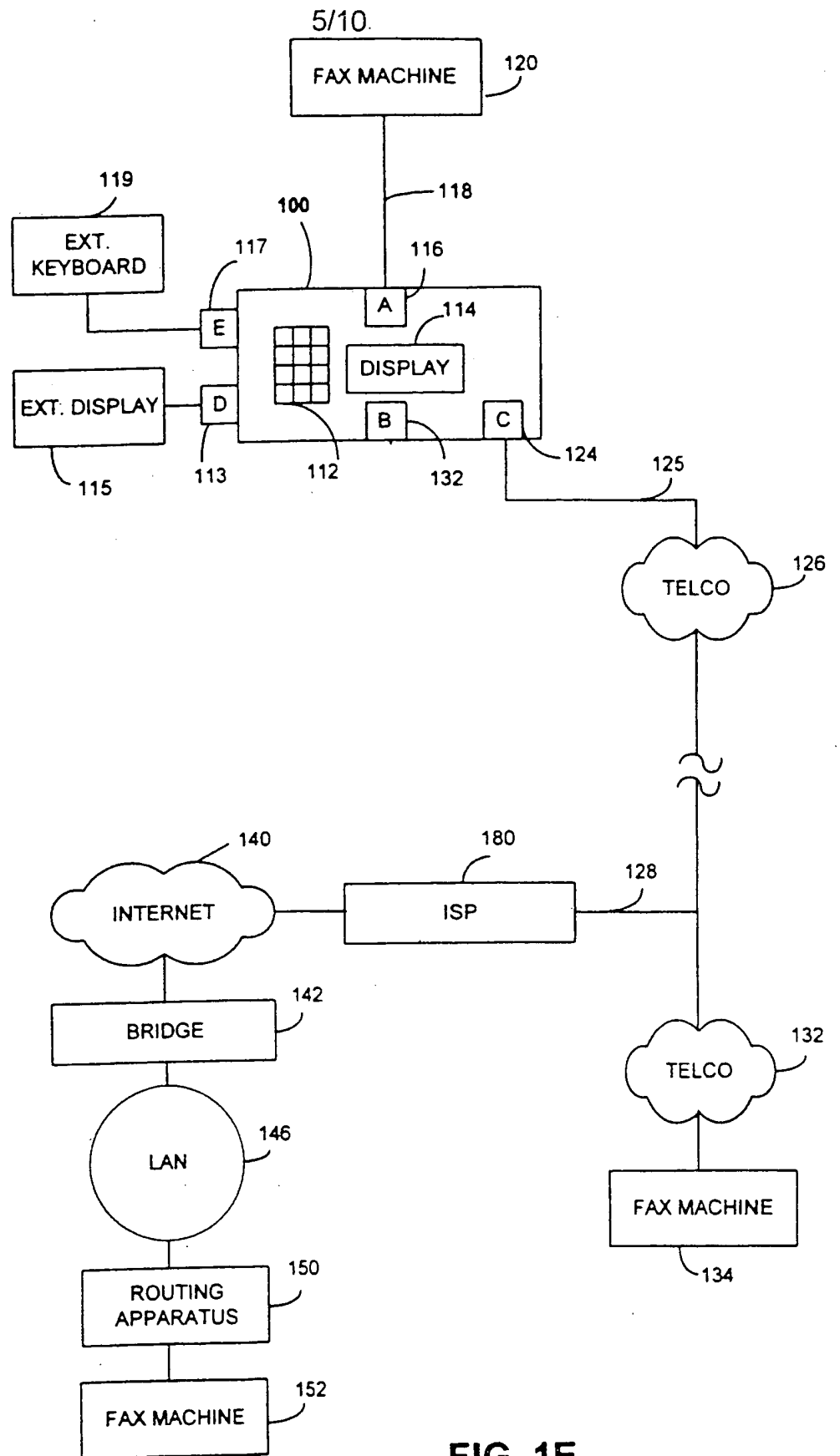


FIG. 1E

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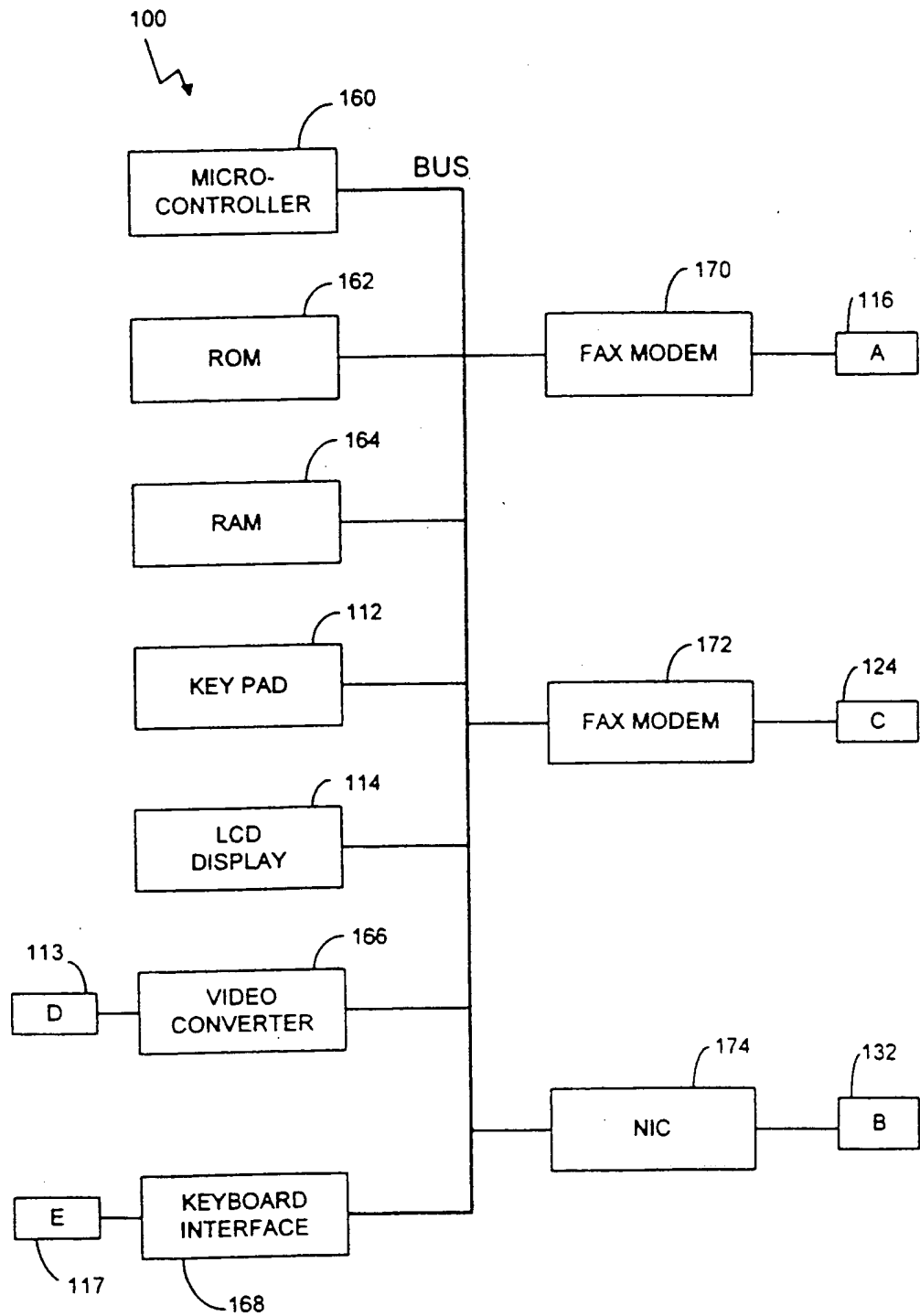


FIG. 2

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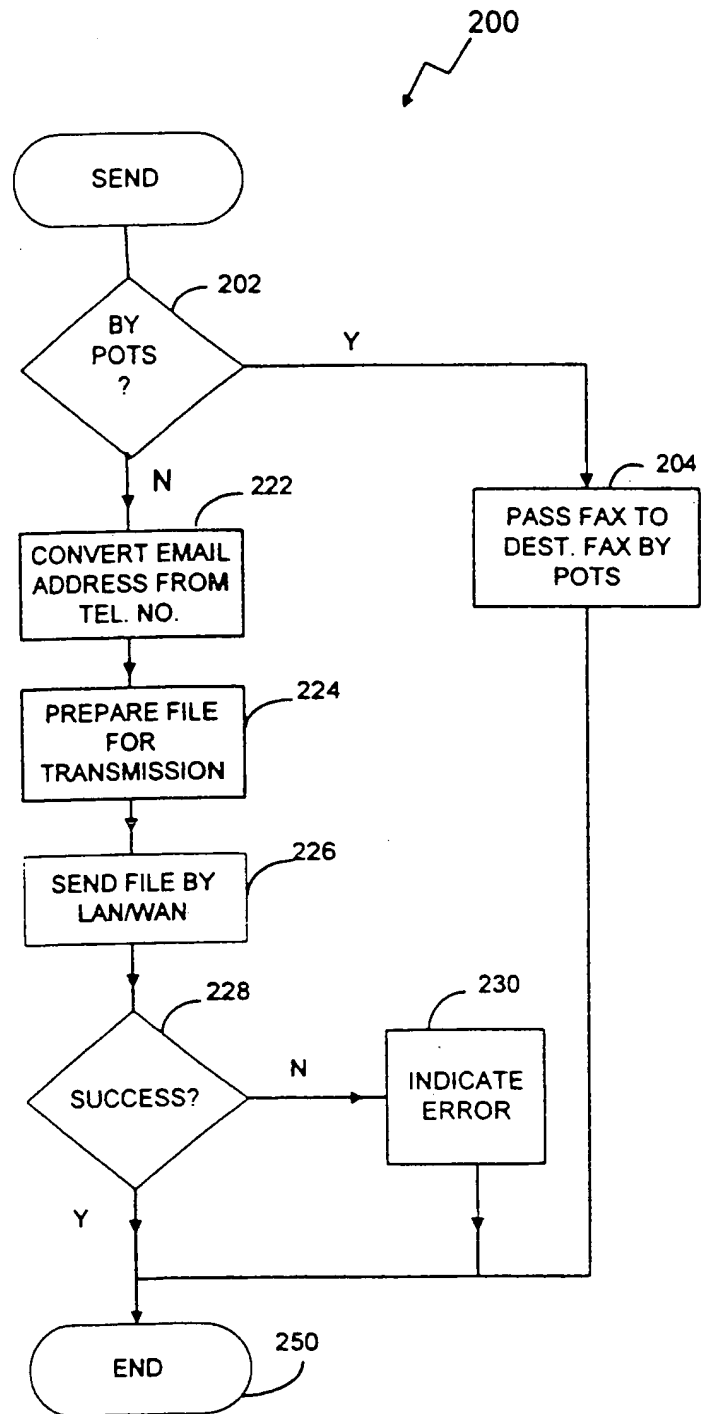


FIG. 3

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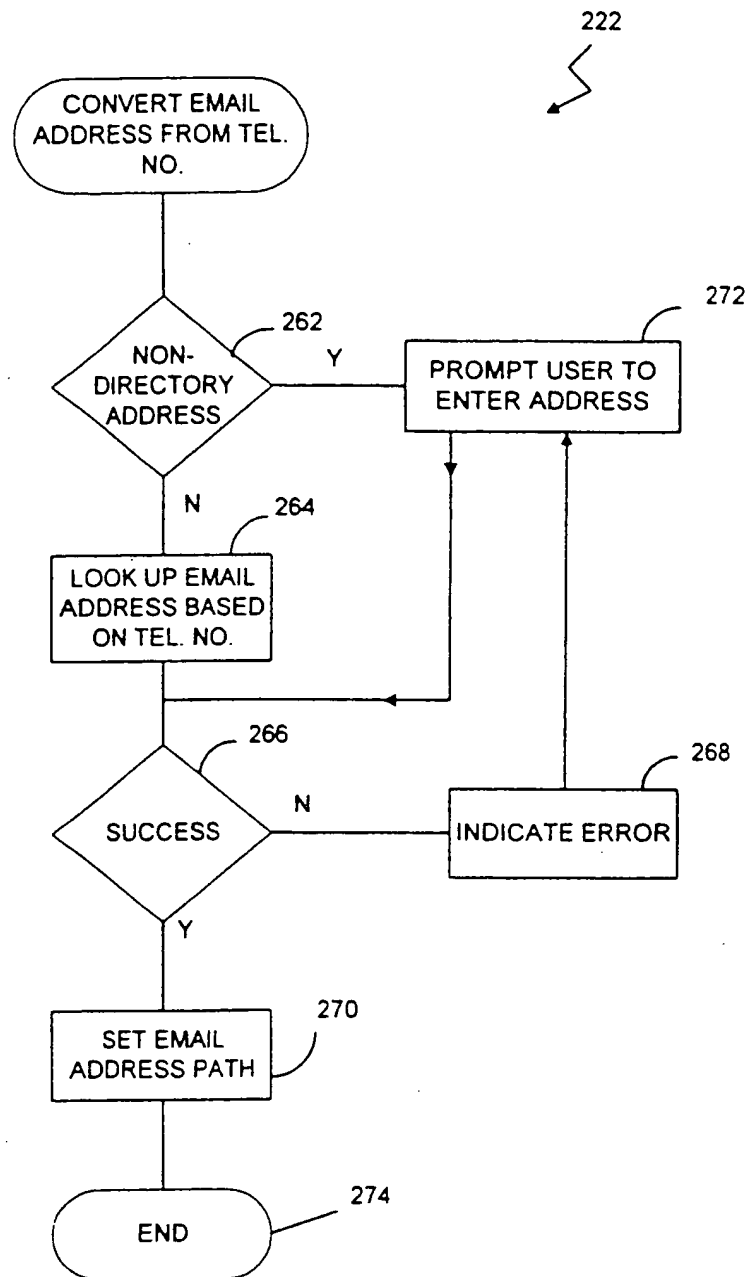


FIG. 4

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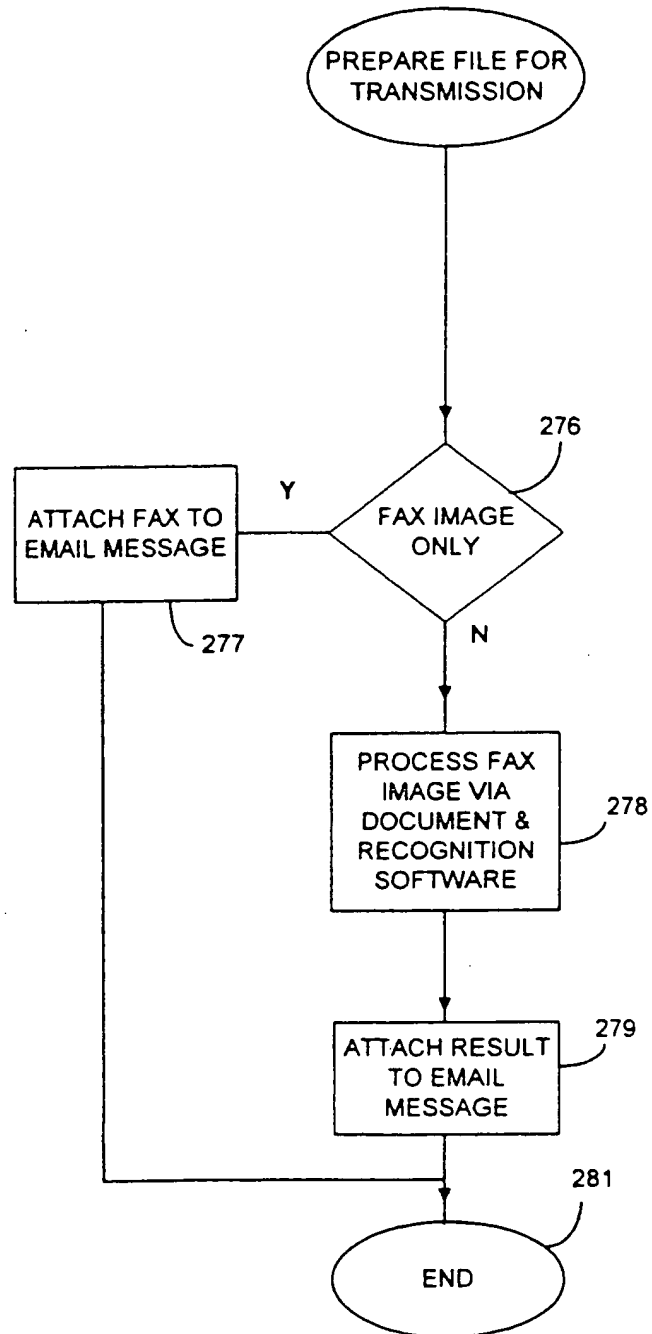


FIG. 5

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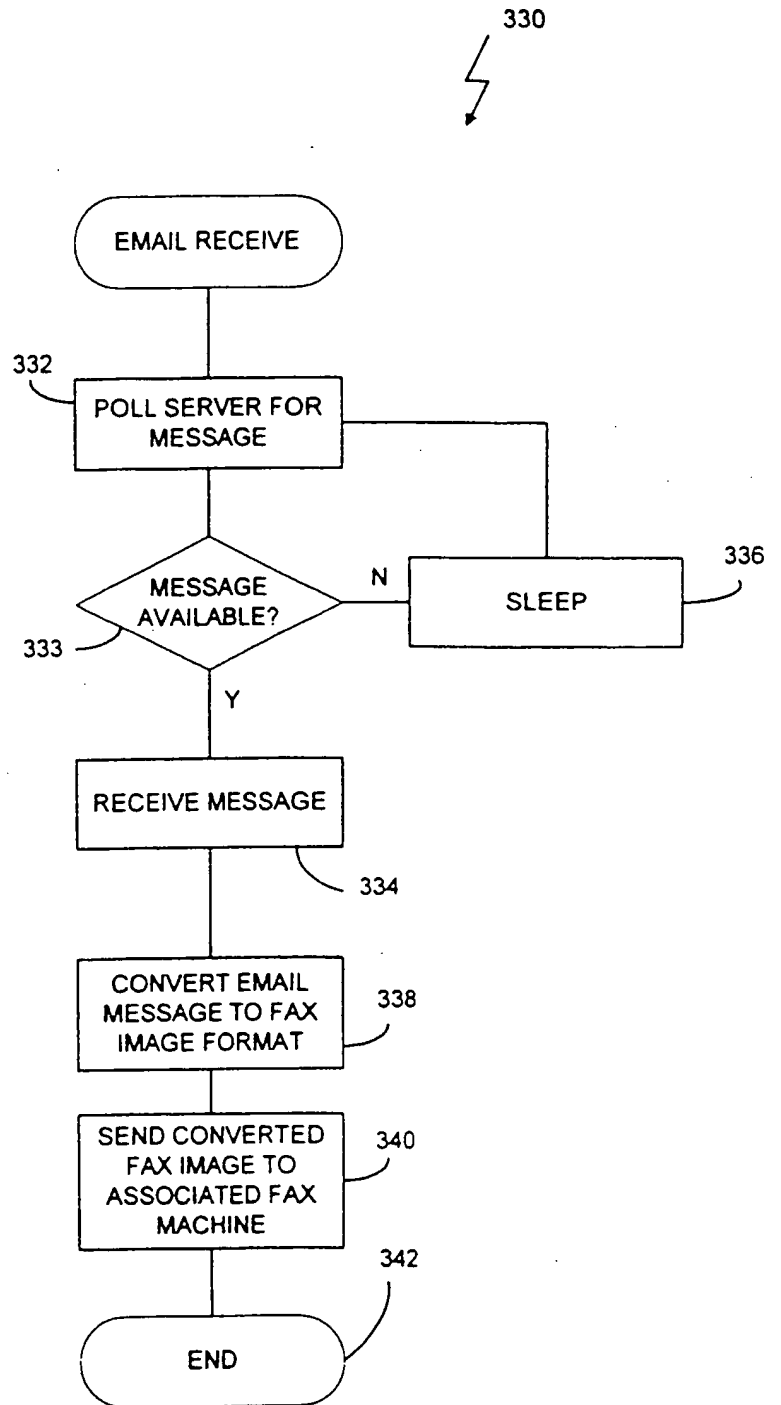


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/22082

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H04N 1/00, 1/32; G06F 17/00

US CL : 358/402, 442; 395/200.68

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

SPS

search terms: routing, router, facsimile, Internet, network, WAN, LAN

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, P ----- Y, P	US 5,815,669 A (LEE et al) 29 September 1998, columns 4 through 6.	1, 3, 9 ----- 1-8
X, P ----- Y, P	US 5,812,278 A (TOYODA et al) 22 September 1998, columns 20 through 29.	16, 17, 19, 20, 22, 23 ----- 1-8, 10-15, 18, 21
Y, P	US 5,805,298 A (HO et al) 08 September 1998, columns 3 through 8.	10-15, 18
Y	WO 96/41463 A (GESHWIND) 19 December 1996, see entire document.	1-8, 10-15, 18, 21



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents

A document defining the general state of the art which is not considered to be of particular relevance

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O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X

document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y

document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Z

document member of the same patent family

Date of the actual completion of the international search

22 JANUARY 1999

Date of mailing of the international search report

08 MAR 1999

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/22082

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, E	US 5,838,461 A (HSIEH) 17 November 1998, see entire document.	1-23
A, P	US 5,719,688 A (KAGAMI) 17 February 1998, columns 2 through 7.	1-23
A, P	US 5,712,907 A (WEGNER et al) 27 January 1998, columns 7 through 13.	1-23

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US98/22082

B. FIELDS SEARCHED

Minimum documentation searched

Classification System: U.S.

358/400, 402, 403, 404, 440, 442, 443, 444, 447, 468; 395/200.31, 200.36, 200.38, 200.42, 200.47, 200.48, 200.49, 200.68, 200.74, 200.79; 379/90.01, 93.24, 100.01